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Conversion of sano plant to solid (charcoal) product by pyrolysis

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Abstract

This paper deals with slow pyrolysis of sano plant (weed) at the final temperature limit of the pyrolysis processes was 500°C. The sano plants have diameters between 10-20 mm and the length of 50-150mm The yield of conversion the sano plants to charcoal was about 23.02% by weight. The gross calorific value is about 26.84 $MJ.kg^{-1}$. An ultimate analysis showed that the composition of the charcoal consist of C 79.8%, H 2.8%, N 0.87%, S 0.11% and O 8.5% Meanwhile, a proximate analysis showed that the fix carbon 72.4%, volatile matter 13.1%, moisture 6.6% and ash 7.9%. Further work is required to acquired complete understanding of the densification process before good quality and durable briquettes could be made.

1. Introduction

The increasing use of fossil fuels for energy production is a matter of concern, both with regard to possible effects on the global climate from the increase in atmospheric carbon dioxide, and in a long-term perspective because the resources are limited. Biomass is normally the main source of energy in the domestic sector for developing counties [1]. The pyrolysis of biomass is a promising route for the production of solid (charcoal), liquid (tar and other organics) and gaseous products (H_2, CO_2, CO). These products are of interest as they are possible alternate sources of energy. Pyrolysis is a process by which a biomass feedstock is thermally degraded in the absence of oxygen/air. The study of pyrolysis is gaining increasing importance, as it is not only an independent process, but it is also a first step in the gasification or combustion process. The basic phenomena that take place during pyrolysis are: (1) heat transfer from a heat source, leading to an increase in temperature inside the fuel; (2) initiation of pyrolysis reactions due to this increased temperature, leading to release of volatiles and the formation of char; (3) outflow of volatiles, resulting in heat transfer between the hot volatiles and cooler unpyrolysed fuel; (4) condensation of some of the volatiles in cooler parts of the fuel to produce tar; and (5) auto-catalytic secondary pyrolysis reactions due to these interactions.

A significant part of the new thernochemical conversion methods for wood-based materials is performed under pyrolytic condition [2]. Pyrolysis has been shown as an effective means of converting bark into bio-oil, gas and wood charcoal, which be useful as feel or chemical sources [3]. The present work focused on studying the pyrolysis of sano plant (Botanical name: Strychnos nuxvomica); one of the useless weed in farm. The specific objective of this study was to assess the potential of the pyrolysis technology to transform weed to useful products such as pyrolysis charcoal.

2. Methods

2.1 Materials

The sano plants from farm were obtained from Mahasarakham province. The particles diameter and length were 10-20 mm. and 50-150 mm, respectively. Prior to use, the samples were also dried by open sun at ambient temperature, and found to process a moisture content of approximately 18%.

2.2 Pyrolysis

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The experiments were performed with 35 kg of biomass feedstock in a fixed-bed reactor with a volume of 200 liters (Fig.1); heated by a furnance with the temperature being controlled by a thermocouple inside the bed. Experiments were designed to controlled both the heating rate and temperature of pyrolysis was 5^{o}C. min^{-1} and 500^{o}C, respectively.

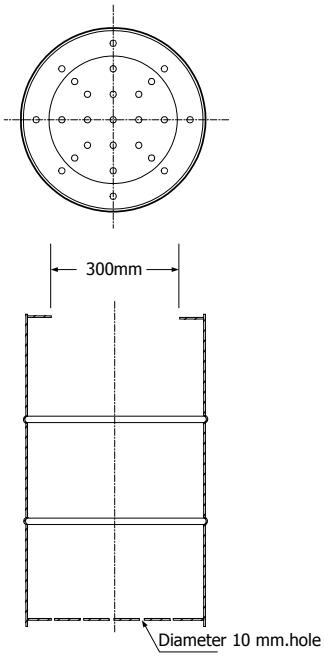

Fig1 A fixed-bed reactor

3. Results

The characteristics of sano coal are given in Table 1.

Table 1. Main characteristics of sano plant

Characteristics	Sano plant
Moisture content (%)	6.6
Proximate analysis (%)	
Volatile	13.1
Fixed carbon	72.4
Ash	7.9
Ultimate analysis[a] (%)	
Carbon	79.8
Hydrogen	2.8
Oxygen	8.5
Nitrogen	0.87

[a] weight percentage on dry basis

3.1 Comparison of heating value of sano plant with another agricultural biomass

The heating value of sano plant was measured by Bomb Calorimeter. A comparison of heating value of sano plant with another agricultural biomass namely: coconut shell, eucalyptus wood, corn cob, peanut bull, rice husk [4] and palm shell and fibber [5] is shown in Table 2. It was found that sano plant had high heating value than rice husk.

Table 2. The comparison of heating value at different biomass products.

Type	Heating value (MJ/kg)
Sano	14.68
Coconut shell	15.66
Eucalyptus wood	16.56
Corn cob	17.62
Peanut hull	18.57
Rice husk	12
Palm shell and fiber	16.38

The product yield from the pyrolysis of sano plant with heating rate 5.5 ^{o}C. min^{-1} was about 23.02% by weight. The sano coal is ground to powder in a milling machine. After that mixed with water and starch as binders to make briquetts. The best mixer was 1:7 (coal : blend). The gross calorific value is about 26.84 MJ.kg^{-1}.

3.2 Boiling Water test

The test were conducted at 3 types of coals namely general wood, eucalyptus wood and sano plant. The 500 g of each all coals were used to boil the 2000 g of water. It was found that the water temperature is increased from 30 ^{o}C to 100^{o}C within 10 minutes by sano and eucalyptus coals. Meanwhile, general wood coal used 25 minutes for increased water temperature to 100 ^{o}C as shown is Fig.2.

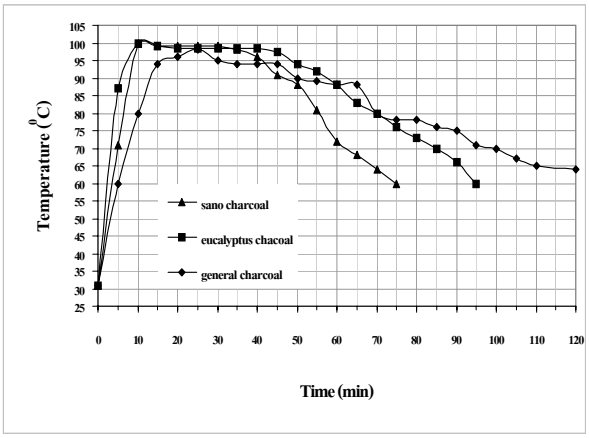

Fig.2 Water temperature versus time for boiling water test of three different biocoals.

4. Conclusion

A weed, sano plant is taken as the biomass sample for the pyrolysis experiments performed in a fixed bed reactor. The charcoal yield was obtained as 23.02% by weight from pyrolysis sano plant at the final pyrolysis temperature of 500^{o}C, with the samples having particle size diameter of 40 mm. and the length of 50-150 mm. and with a heating rate of 5.5^{o}C, min^{-1}. The heating value of sano plant was higher than rice hunk about 2.68 MJ.kg^{-1}. The sano coal had the gross calorific value of 26.84 MJ.kg^{-1} at the mixer component of 1:7 (coal : blend). Therefore, the experimented investigation indicated that the use of sano plant to convert to charcoal by pyrolysis is feasible.

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